PO No. HO/4500123381 Date: 13th January 2023
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Final Report

DPR

Procurement of
CW Pump Module with Mandatory Spares for
250 MW Paras TPS
Dist. Akola, Maharashtra

Report submitted by

TÜV SÜD South Asia Pvt Ltd.
Mumbai (India)

CONTENTS

PAN No.: AABCT0716G
TAN No.: MUMT09385F
CI No.: U74220MH1999PTC121330
GST Reg No.: 27AABCT0716G1ZN

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1. Introduction to Present System (Installed)-

Paras TPS consists of 2 x 250 Mw sets. Unit no 3 & 4 commissioned on 31st Mar 2008 & 31st Aug 2010 respectively.

At 2 x 250 Mw Paras TPS, total Six CW pumps (2 working + 1 Standby for each unit) of BHEL make (Model no. BHEL 1Q) are installed for condenser cooling water cycle.

These pumps are in continuous operation since commissioning of respective unit. CW Pumps comes under vital 6.6 KV critical and important auxiliary.

The necessities of schemes in detail are mentioned as below.

During routine overhauling, it is observed that, critical pump parts such as Suction casing, impeller casing, pump casing, impeller etc. found corroded/wear out heavily due to aging effect/continuous service (photos attached).

Same is repaired and pumps are taken in service. However, problems such as, high power consumption (> 20 amps than rated), knocking sound, vibration etc. occurred repetitively.

At present, Unit 4 CW-A is out of service due to damaged pump suction casing, impeller and impeller casing, pump casing etc.

Repairing time is more than 3 months. Hence, it is intended to procure two CW pump parts (complete pump will be assembled at site) along with mandatory spares from OEM through capex scheme.

Availability of complete pump parts may reduce down time of CW pump, subsequently the prevention of generation loss during any unforeseen emergency.

In order to repair the pump, Paras TPS has ordered major spares like, cut less bearing assembly, shaft sleeves, thrust bearings etc.

Also repair work undertaken for Impeller, bowl assembly, pump casing etc. These spares and repair works required approximately three months of delivery period.

Due to these, pump may be out of service for 4 to 5 months. If station has a spare pump assembly, it could have taken in service within 8 to 10 days. Unit 3 CW–C consumes more power (> 20 amps) than rated power consumption.

If complete pump available, replacement may be completed within 8 to 10 days with quality work.

2. Current Process-

Unit 4 CW A, dismantled due to high vibration, heavy rubbing sound and overload tripping of motor. Damaged parts such as impeller, impeller casing, pump casing, suction casing, cut-less bearing, shaft sleeves etc. sent for repairing.

Pump CW-4C having abnormal sound in coupling and thrust bearing assembly, which need to be taken up. Most of major Mandatory spares consumed during routine maintenance work.

3. Condition of asset under replacement-

At Paras TPS, each unit having three numbers of CW pumps (Total six no), out of which, two are running continuously for full load and one is in auto standby. CW Pumps installed at U#3&4 Paras TPS are in service since its commissioning i.e., for more than @ 10 years.

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During routine overhauling, it is observed that, critical pump parts such as Suction casing, impeller casing, pump casing, impeller etc. found corroded/worn out heavily due to aging/continuous service. These critical parts were repaired and pumps were taken in service.

However, problems such as, high power consumption (20 Amps higher than rated), knocking sound, vibration etc. occurred repetitively.

Presently, U#4 CW-A is out of service due to damaged pump suction casing, impeller and impeller casing, pump casing etc.

Repairing time is more than 3 months. Also, CW Pump at U#3; CW-3C is repaired but its consumption is 20 A higher than rated current & CW-4C is having high vibrations & repeated knocking sound.

Hence, it is intended to procure two CW pump Assemblies (complete pump will be assembled at site) along with mandatory spares from OEM through capex scheme.

Availability of complete pump parts may reduce down time of CW pump, subsequently it will lead to the prevention of generation loss during any unforeseen emergency.

As per the efficiency test carried out in May 2023 for asserting the pump dynamic performance there is a potential of improvement from 15% to 30% in CW pump performance.

4. Key issues/Problems faced-

- Unit 3 CW–C Current consumption found more (20 amps.) as compared to other running pumps and Unit 4 CW–A dismantled due to high vibration, heavy rubbing sound and overload tripping of motor.
- After dismantling it is observed that, heavy rubbing of impeller with impeller casing, complete deterioration of bowl assembly, column pipes etc.
- In order to repair the pump, Paras TPS have ordered major spares like Impeller, cut less bearing assembly, shaft sleeves, thrust bearings etc.
- Also repair work undertaken for Impeller, Impeller bowl assembly, Coolum pipes etc.
- These spares required 3 months of delivery period.
- Due to these factors Pump is out of service for 3 to 4 months.
- CW–4C Knocking sound observed in thrust bearing and coupling assembly.
- In order to take up the work, plant load need to be lower down to half of its capacity. At present no spares are available at Paras TPS.
- As per the efficiency test carried out in May 2023 for asserting the pump dynamic performance there is a potential of improvement from 15 to 30% in CW pump performance.

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5. Alternatives for replacement-

Option 1	Repair of CW PUMP damaged parts.	**Disadvantage:** • Repair of CW PUMP damaged parts. • The period required to repair the damaged parts is approximately more than 4 months. • During this repairing if any problem occurs to the running CW, then there may be half generation loss of a unit, • Repaired pump parts replacement will be a tedious job as compared to replacement of new spares. • There may be a risk in repairing of damaged parts as it is totally depending on the technical skills of repairing agency.
Option 2 (Selected Option)	**Procurement of CW Pump Module with Mandatory Spares for 250 Mw Paras TPS**	**Advantage:** • Availability of new spare CW pump may avoid generation loss of unit during any emergency. • New pump parts will be a quality job as compared to replacement of repaired parts and hence it will be a reliable maintenance process. • Condenser cooling water flow may be maintained at rated power consumption. • Outage time of pumps after unforeseen failure will be reduced. • Tripping of unit due to unavailability of standby pump may be avoided, which avoid generation loss. • Vacuum required in condenser for full load will be maintained. • Approximate financial benefits by Total saving 3.27 Cr. per year for two pumps. • In case of U#4 standby pump not available. So, failure running pump will cause reduction in cooling water flow which will tend to increase pressure in condenser which will deteriorate vacuum. • To maintain set in running condition TPS need to decrease load. This generation loss will be avoided. • Availability of complete pump for replacement will be a quality job as compared to replacement of repaired pump parts and hence it will be a reliable maintenance process. • The OEM supplied CW pump will be an efficient one than the repaired one • As per the efficiency test carried out in May 2023 for asserting the pump dynamic performance there is a potential of improvement from 15 to 30% in CW pump performance.

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6. Essentiality of Procurement-

Pump Condition Monitoring by Thermodynamic Pump Performance Measurement System Third party at MAHAGENCO Thermal Power Plant, Paras on Date – 24rd May 2023 to 26th May was carried as per requirement to access performance.

Thermodynamic pump testing is a form of pump testing where only the temperature rise, power consumed, and differential pressure need to be measured to find the efficiency of a pump.

These measurements are typically made with insertion temperature probes and pressure probes fitted to tapping points on the pump's inlet and outlet. From these measurements, the flow produced by a pump can be derived.

The thermodynamic method was developed in the early 1960s, and since has been increasingly used. It is described in high precision hydraulic testing standards such as ISO 5198.

The thermodynamic method is used for performance testing of pumps, flow meter calibration, system curve tests, and other applications.

It is capable of achieving results with uncertainties of less than 1% in pump efficiency and less than 1.5% in flow while being able to test pumping configurations where other conventional pump testing methods cannot provide accurate results.

The inefficiency of pumps is transmitted through the medium of temperature. Thus, nearly all of the energy lost due to the inefficiency of a pump causes an increase in temperature of the fluid which is being pumped.

The thermodynamic method takes advantage of this fact, and precisely measures the temperature difference across a pump to calculate the pump’s efficiency.

Pressure measurements are used to calculate the head of the pump, and a power meter is used to measure input power to the pump. Using the measurements of temperature, power, and pressure, flow can be back-calculated using the pump equation.

The temperature measurement is critical, and consequently commercial distributors of thermodynamic pump testing equipment often quote an accuracy of greater than 0.001°C.

Such accuracy is necessary as the temperature rise across a pump may be less than 0.05°C Typically, temperature probes are inserted directly into the flow, and pressure measurements are taken from taps on both the suction and discharge sections of the pipe.

The conventional method requires more stringent piping requirements, usually requiring greater than 5 diameters of straight pipe upstream of the flow meter in order to provide the quoted flow accuracy.

In Thermodynamic pump performance monitoring system, it is necessary to measure temp.

Difference (ΔT) between pump suction and discharge very precisely and pressure difference (ΔP) between pump suction and discharge line.

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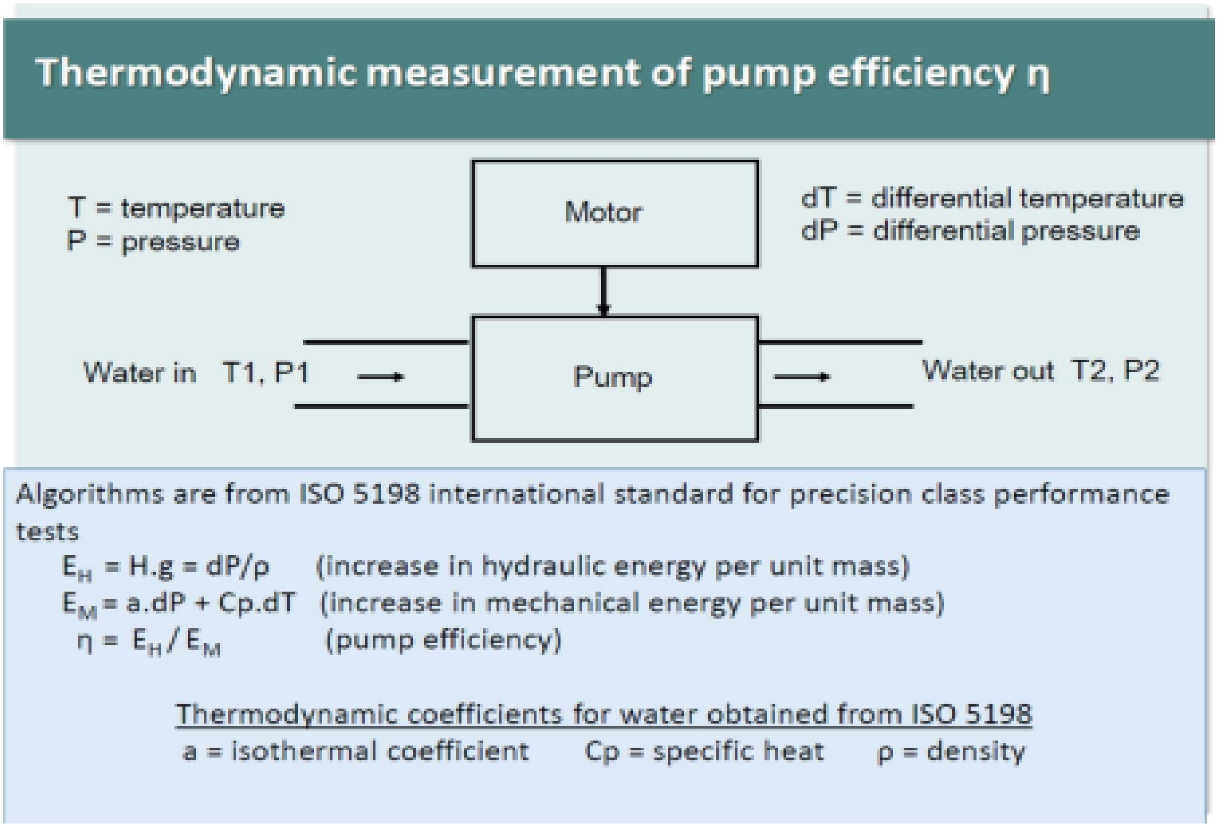
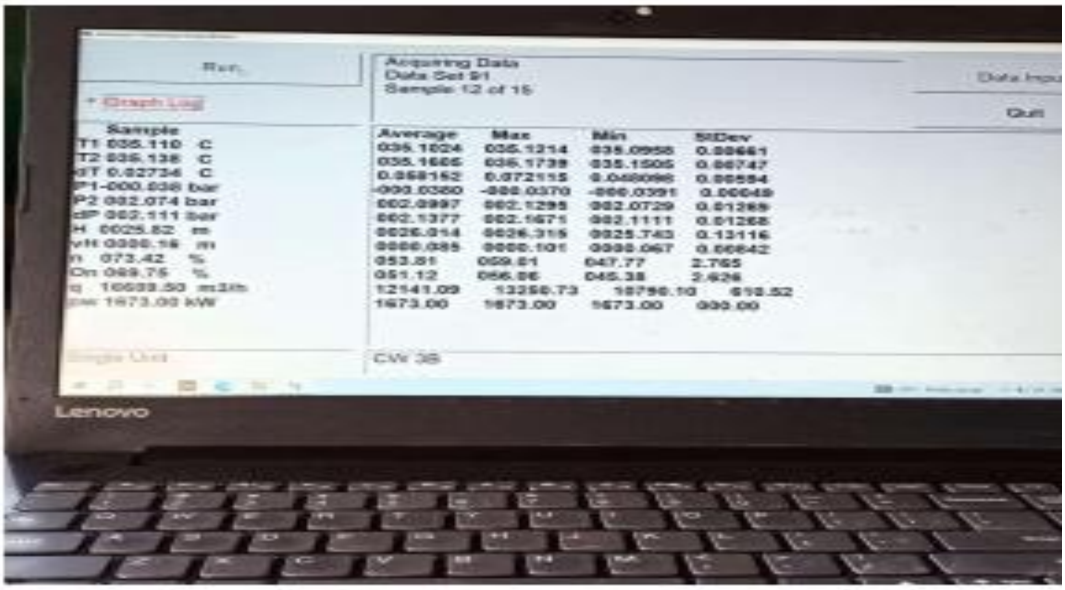
Methodology and process to get the efficiency of the pump.

Discharge Side Pressure Probe & Temperature Probe



Data recording of the pump pressure and temperature parameters.



Results of the pump performance and scope for improvement in efficiency of the pump

System Details	Existing Pump Efficiencies %	Action Short Term	Estimated Efficiency rise up to %	Action Long Term	Estimated efficiency Rise up to %
Condenser Cooling Water Pump 3A	67.54	Refurbishment of pumps with replacement of certain spares and corrocoat	5%	Replacement of Bowl assembly with corrocoating of pump	13-15%
Condenser Cooling Water Pump 3B	67.19	Refurbishment of pumps with replacement of certain spares and corrocoat	5%	Replacement of Bowl assembly with corrocoating of pump	13-15%
Condenser Cooling Water Pump 3C	53.97	Refurbishment of pumps with replacement of certain spares and corrocoat	5%	Replacement of Bowl assembly with corrocoating of pump	26-29%
Condenser Cooling Water Pump 4A	72.63	Refurbishment of pumps with replacement of certain spares and corrocoat	5%	Replacement of Bowl assembly with corrocoating of pump	8-10%
Condenser Cooling Water Pump 4B	64.69	Refurbishment of pumps with replacement of certain spares and corrocoat	5%	Replacement of Bowl assembly with corrocoating of pump	15-17%
Condenser Cooling Water Pump 4C	65.73	Refurbishment of pumps with replacement of certain spares and corrocoat	5%	Replacement of Bowl assembly with corrocoating of pump	15-17%

Existing Pump Efficiency and Estimated rise in Pump Efficiency after replacement						
CW Pump	3A	3B	3C	4A	4B	4C
Existing Pump Efficiency	67.54	67.19	53.97	72.63	64.69	65.73
Estimated rise in Pump Efficiency after replacement of pump.	**15**	**15**	**29**	**10**	**17**	**17**

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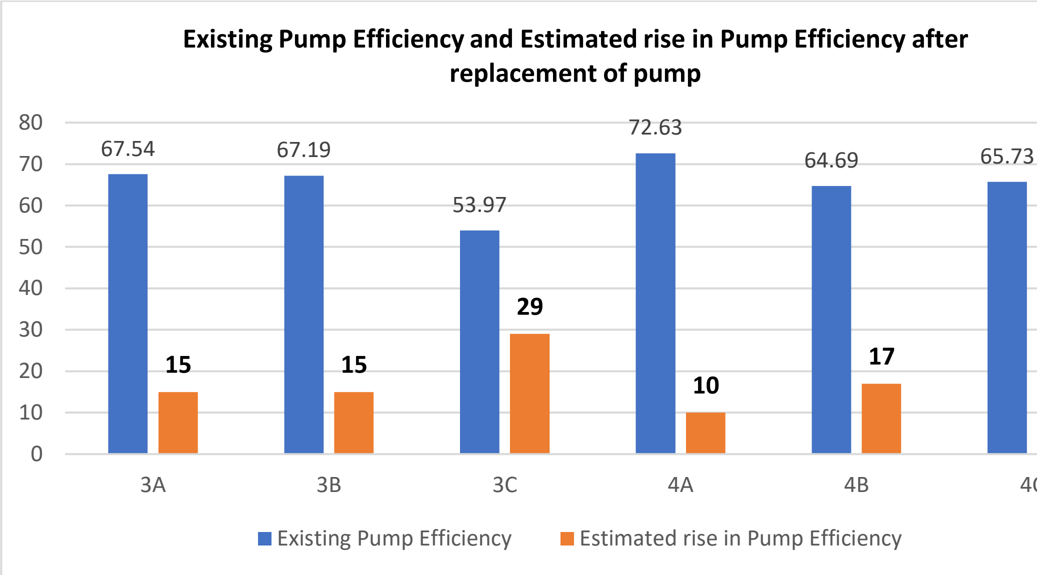

Photographs showing damages to the body and internals

Photographs showing damages to the body and internals

Close view of impeller casing and liner assembly

Through hole to impeller casing and liner assembly

Pitting on outside surface of impeller casing

Through hole to suction casing assembly at various locations

Close view of Pitting/cavitation on impeller blades

Pitting/cavitation on impeller

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Pump casing bolt complete wear out, pitting on casing wear ring

Photographs showing damages to the body and internals

Pump casing inside surface pitting at various locations

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Rubbing of Impeller casing observed

Pump Casing fasteners rubbing and cutless bearing housing along with casing material (Blue color) found complete damage.

Damaged Impeller, Impeller ring along with impeller vanes rubbing observed.

Photographs showing damages to the body and internals

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Head Shaft Brocken twice

Shaft Sleeve removed by cutting, needs to replace during every overhaul opportunity.

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7. Least cost analysis-

Considering current scenario, CW-4A is not available & if any of the running pump trips on unforeseen emergency then Unit needs to be run on a half load.

Hence Fixed Cost loss of 125 MW may occur on this account

Average AFC for FY 21 to FY 25 = 577.75+557.62+469.08+460.25+464.16)/5

= 505.772 Crore

Approved Gross Generation = 3499.22 MUs

For one day = 505.772/365 = 1.39 Cr./day

For one unit = 1.39/2 = 0.69Cr./day/unit

There will fix charges loss for 125 MW Generation loss per day

Loss of Fixed charges = 0.69 x 0.5 = 0.35 Cr./Day

Considering availability of spare pump for immediate replacement, it takes 8 to 10 days for replacement and brought system in operation.

For repair and replacement same will take approximate three months Hence, generation loss for 80 days can be saved = 0.35 x 80

Readily available CW Pump spares will cause the saving of Generation loss for @ 80 days in case of emergent situation within its service span of @ 10 years.

= 80 X 0.35 Crore.

= INR 27.7 Crore may be saved over the span of 10 years; hence saving/Year can be apportioned to (30/10) @ **INR. 2.7 Cr/**-………………. (a)

Considering the reduction in Auxiliary consumption of the pumps.

Reduction in Full load current of CW Pump & thereby reduction in Power Consumption

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$= 1.732 \times 6.6 \times 20 \times 0.8$

$= 182.90$ kwh

Total Power Saving Per Day in MUS $= 182.90 \times 24/10^6$

$= 0.0043896$ MUs.

Annual Power saving $= 0.0043896 \times 365$

$= 1.602$ MUs.

Allowable Energy Charges approved by MERC (average of 5 years) Rs. 3.11/kwh, therefore, total saving Per Year in (Rs) $= 3.11 \times 1.602 \times 10^6$

= INR. **49,82,220**……………………………………….(b)

Considering (a) & (b) above, annual saving comes to the tune of INR 3.27 Crore can be achieved on implementation of the scheme.

Total Project cost will be 15.28 Cr.

Payback period through saving of energy and fixed cost = 15.28/3.27 = 4.66 Years.

*MERC Order 296 for 4rd MYT control period Page No 186 & 221.

Proposed Benefits/Key performance indicators:

Technical Improvements:

- Condenser cooling water flow may be maintained at rated power consumption.
- Outage time of pumps after unforeseen failure will be reduced.
- Tripping of unit due to unavailability of standby pump may be avoided, which avoid generation loss.
- Vacuum required in condenser for full load will be maintained.
- Availability of spare CW pump may avoid generation loss during any emergency.
- Replacement of new pump with old one will reduce auxiliary power consumption (~20 Amps.)
- Availability of CW pump may reduce the down time in case of any unforeseen emergency.

Financial Benefits:

- Approximate financial benefits by Total saving 3.27 Cr. per year for two pumps.
- In case of U#4 standby pump not available. So, failure running pump will cause reduction in cooling water flow which will tend to increase pressure in condenser which will deteriorate vacuum. To maintain set in running condition TPS need to decrease load. This generation loss will be avoided.

Quality/Service/Reliability Improvement:

- Availability of complete pump for replacement will be a quality job as compared to replacement of repaired pump parts and hence it will be a reliable maintenance process.

Process Efficiency Improvement

- The OEM supplied CW pump will be an efficient one than the repaired one.
- Reduction in auxiliary power consumption > 40 Amp (for two pumps). i.e., 365.80 KWH or 3.2044 MUs per year by virtue of efficiency improvement potential ranging from 15 to

30% as per the efficiency test carried out in May 2023 for asserting the pump dynamic performance.

- Cooling water flow may be maintained on the rated current.

Impact of improvements on plant parameters

- Reduction in auxiliary power consumption > 20 Amp (for two pumps it will be @ 40A).

8. Recommendations-

Considering,

1. Physical inspection, verification at site and photographs of damaged parts.
2. Condition of the CW pump impeller and body,
3. Energy saving potential as per the efficiency test carried out in May 2023 for asserting the pump dynamic performance,
4. Loss reduction potential due to increase in vacuum by virtue of improvement potential as per efficiency test,
5. Restoration/maintenance of CW pump within a stipulated AOH/COH period so as to keep standby pump availability,
6. Upstream and downstream component condition assessment for healthiness of the system,

Procurement of CW Pump Module with Mandatory Spares for 250 MW Paras TPS is the only option to ensure efficiency, availability, reliability and improvement in operation parameters of the unit.

It is better to Procure CW Pump Module with Mandatory Spares for 250 MW Paras TPS and hence the scheme is **recommended**.

9. Conclusion-

In view of above details and the DPR sent for scrutiny, need and information, The proposed scheme for Procurement of CW Pump Module with Mandatory Spares for 250 MW Paras TPS is **recommended** for implementation.

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